

Web-Based Delivery and Open-Architecture Database Support in the ITreS Counselor Information System

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ITreS is a prototype information system for substance abuse counselors and clinicians. ITreS integrates client records, on-line screening and assessment instruments, and knowledge bases into a single integrated system. This paper discusses two aspects of the development of ITreS: the use of the World Wide Web as a development and delivery environment and the use of an attributed translation-based data model to integrate data from various sources into a single client record.

INTRODUCTION

Throughout the process of substance abuse treatment, substance abuse counselors and clinicians must find and digest large quantities of information from a multitude of sources. Given the continually growing quantity of information available, these professionals have neither the time nor the resources to find the best information relevant to the tasks at hand.

To successfully assist substance abuse counselors and clinicians, a computerized information system must support managed access to client data and resources, integration of information and applications, and the transfer of the best available relevant knowledge in a meaningful, user-friendly presentation. We are developing a prototype counselor information system known as Information Transfer System (ITreS) with support for integration of diverse information and transfer of relevant knowledge to enable substance abuse professionals to make informed decisions about their clients.

REQUIREMENTS

The ITreS project began with extensive interviews, discussions, and focus group meetings with substance abuse treatment professionals in both clinical and social service settings. Through this process, we identified the following critical requirements:

- Efficient retrieval and dissemination of information
- Integration of diverse resources
- Support for normal work flow
- Support for customization by facility or site

- Integration with existing applications and instruments
- Secure sharing of client records with relevant personnel
- Ease of use

We also recognized that platform independence would be an important implementation issue (since most substance abuse counseling facilities have very limited funds) and indeed that ITreS should run on inexpensive commercial personal computers. Furthermore, we identified several areas where ITreS could provide extensive leverage over existing procedures and systems:

- The ability to link related information from diverse sources
- Integrated records and reference information
- Task-driven access to reference information

OVERVIEW

This paper discusses two of the major design features in the ITreS system. First, we discuss the use of the World Wide Web as a development and delivery environment, and then we discuss the use of an attributed, translation-based data model for client records.

The screens shown are from an early prototype used to obtain further feedback from practitioners. The ITreS system is continually evolving, both through successive prototypes and as customization allows different users to view the system differently.

DEVELOPMENT AND DELIVERY ENVIRONMENT

Capabilities

We have chosen to use the World Wide Web (Web) as our development and delivery environment. The capabilities of the Web provide a good match for the desired functionality of our prototype system, ITreS:

- Seamless integration and distribution of information
- Cross-platform architecture support

- The client-server architecture and use of standard protocols (HTTP, HTML) result in the seamless integration of information¹. Thus, the Web provides a consistent interface for the presentation of information from varied sources. Through the use of hypertext links, users can easily navigate through information from a variety of sources including our own, commercial and non-profit services, and government resources² (see figure 1).

Figure 1. Screen for reviewing results from the POSIT screening instrument. Areas with high severity scores show a recommendation for further assessment. Following the link provides specific assessments recommended for this client.

User interaction with ITreS is supported through the use of the forms extension to HTML, coupled with the CGI (server-side scripts that create dynamic pages) capabilities of the web server. Documents are dynamically created and displayed in response to information input by the practitioner. Through forms and CGI scripts, ITreS provides information retrieval based upon the needs of the practitioner^{5,6}. We are also using JavaScript, a client-side scripting language, to enhance user interaction by responding to lower-level

user input (e.g., mouse button clicks) and to validate form input⁷. HTML, CGI, and JavaScript together provide the same flexibility as locally-executing forms-based applications (see figure 2).

Figure 2. An ITres client record screen. Tabs along the bottom of the screen allow the user to select other record categories. Controls in the top-left corner access calendar and client record selection screens. Buttons on the top right select other parts of the system.

From the perspective of the developer, the Web is a conducive environment for rapid application development and prototyping. With the ease of access to the Web, prospective end-users can test our system and provide instantaneous feedback.

While the features of developing using the Web are well-suited for satisfying the requirements of our system, we have encountered certain obstacles which must be overcome:

- It is an important goal of ITreS to incorporate external applications, ranging from insurance and financial software to computer-based assessments, into a unified framework. The external application interface makes it easy for the web server to initiate these applications and pass data to them, but there is no provision for ongoing control or for the external application to transmit its data to the server. We are

exploring several techniques for addressing this problem including the use of plug-in applications, the Java extension to Web browsers (which can safely transmit data back to the server), and other techniques.

One of the properties of the Web is the flexible presentation model. HTML describes user interface layout at a high-level, but the user's browser actually performs the layout based on several factors including screen size, user font preferences, and other user preferences. This can be very beneficial to users with poor eyesight, for example, but it also limits the control that the designers have over the interface. We are using Netscape Frames⁸ to impose some layout restrictions, but frames only control space allocated to different screen tiles. A growing problem is the incompatibility of many Web pages with different browsers. Compatibility is an issue that we will need to address as we move from prototype to product.

The Web protocol is connectionless, which makes it difficult to maintain a user login session. For security purposes, therefore, we have adopted the same method as others⁹ where we require an initial login and then keep a hidden token active for a period of time. We have not yet assessed the effectiveness of this model in more open point-of-care environments. We may need to reduce the time-out or have an explicit logout option readily available.

The ability to customize the system for different needs is a critical feature of ITreS. Different customers may choose to use different guidelines, instruments, and record-keeping standards. Since the software is not "delivered" to a customer, customization is a different problem in the Web. We expect to support customization in two ways: 1) large customers, such as health maintenance organizations or hospital chains, will be able to operate their own local servers with custom screens and options, and 2) smaller customers will have a menu of available modules that they can select at subscription time -- users will have those modules available through the dynamic form creation described above.

Design Lessons

customization of forms and data: One approach we take in the implementation of knowledge transfer is through dynamic creation of (Web) documents. Not only are pages generated in response to user input, but, in addition, template documents which are stored and populated with data when needed provide clinicians with access to information tailored to their needs.

portability considerations: While cross-platform support inherent in Web development is a significant advantage, we still need to be conscious of portability

issues. Support for various features and extensions in Web page documents deviates depending upon the browser software used. Similarly, the appearance of the documents themselves is influenced by the display environment of the computer running the client browser.

environment maintenance: To support the tasks of the substance abuse practitioner, we have incorporated the "current client" model. The interaction of a practitioner with a client typically involves repeated handling and manipulation of the client data. Using the "current client" model, identifying information regarding the client is maintained as part of the current environment. Each action initiated by the clinician is then performed with respect to this "current client". To counter the connectionless state of the Web, and provide support for this model, we utilize HTTP cookies. While connections between the Web server and Web clients (browsers) are stateless, HTTP cookies allow clients to retain persistent state between requests to the server¹⁰.

CLIENT RECORD DATA MODEL

Client records include a wide range of information from demographic and insurance information to assessment instrument responses to counselor and clinician notes, summaries, and treatment plans. To achieve the maximum benefit from computerized records, it must be possible to quickly find relevant information and to avoid duplication of unnecessary information. Several professionals told us, during interviews and focus group meetings, that they would welcome a system that avoided the need to repeatedly enter the same information on each successive form or instrument.

At the same time, it is not always clear how data should be related. Responses to questions about drug use during a screening or intake visit may be relevant to, but not replacements for, subsequent assessment. Also, not all forms and instruments use the same scales and parameters. A counselor who is asking about recent cocaine use may be interested in both information about use in the past week and information about use in the past month. Neither answer may replace the need for current information (since "last week" changes over time) but each answer may be relevant when properly identified (e.g., with the time of answer).

Our goal, then, is to design a system with as much flexibility as possible to support:

- An arbitrary set of forms and instruments
- Re-use of data when appropriate
- Display of related data when appropriate

- Links to sources of displayed data

An example of the flexibility that we seek is the use of prior replies during interview assessments (e.g., the CASI-A). As shown in figure 3, the counselor administering CASI-A¹¹ questions about drug abuse problems can see information about the client's prior responses in the POSIT screening instrument. In some cases, the counselor may use these responses to restructure the interview (and may decide to answer some CASI-A questions directly from these notes rather than asking the client). When there are exact matches, and it is appropriate to transfer prior data, the responses may even be pre-selected, with the ability for the counselor to override them. This mode is used for demographic information, for example, since it is seen as repetitive to ask for the same information many times.

The image shows a screenshot of a web-based interview application. The window has a title bar with 'CASI-A: Psychiatric Status'. Inside, there's a question: 'Have you ever had a significant panic during which you were extremely intimidated, shy, felt withdrawn or self-conscious, were afraid of new situations?'. Below the question are radio buttons for 'Yes' and 'No'. To the left of the question is a vertical list of categories: General Information, Substance Use, Medical History, Family Relationships, Social Status, and Treatment History. At the bottom of the window, there are two text areas labeled 'Observations' and 'Treatment Plan Notes'. The top of the window has a navigation bar with 'Save Session', 'Quit', and 'Help' buttons.

Figure 3. Interview screen from CASI-A instrument. Below the question is a display of related information from the POSIT screening tool. At the bottom of the screen are two areas for recording observations and options for the subsequent treatment plan.

The model we use to implement client records is an attributed, translation-based data model. In this model, there is a central client record and a set of form and instrument data records. An attribute refers to a unit of information such as client age or cocaine use history. Each form or instrument requires a translation table that specifies the following:

- Which fields from the client record should be *imported* into the form or instrument to fill in specific fields in the form/instrument
- Which fields from the client record should be read into the form or instrument as *linked* information for specific fields in the form/instrument

- Which fields from the form/instrument should be *exported* to the client record and methods for displaying exported fields as links

The central client record itself has several field types which include sets of links (e.g., the field "prior cocaine use" is a set which simply collects links to all of the prior cocaine use information available for the client). A subtype of sets are sets that have a distinguished value (e.g., the value from the most recent link or the value explicitly selected by the practitioner). In addition, there are single-valued fields of string, number, and date types with and without link attributions.

In use, this data model appears as a star, with all sources and users of data connecting to the central client record. To incorporate a new form or instrument into the system, one need only define a translation table that maps that new form or instrument to the central client record. The table may include *translation functions* (currently written as Perl and Tcl scripts) to convert data between the instrument format and a canonical format (e.g., converting between birth date and age). This functionality is particularly useful when designing discharge and follow-up forms that can be used for all patients, regardless of the specific instruments and procedures they followed during care.

An example of the use of this data model is shown in figure 4. As the counselor selects the CASI-A, relevant information from both intake forms and screening instruments is read into the CASI-A form. When the CASI-A has been completed, new information is inserted into the client record, either as links or as ordinary values.

The attributed, translation-based data base prototype is implemented in the Unix environment using scripts written in the Perl and Tcl scripting languages. Because the data base resides on the Web server, we do not need to be concerned with portability.

SUMMARY

The entire health care profession is in need of better computer-based tools for practitioners.^{12, 13} Next-generation counselor and clinician information systems, as examples of these tools, must integrate a wide range of knowledge and information for users. Part of the challenge to designers is to find effective delivery mechanisms and data models. Our experiences with ITres have shown that the Web has many advantages as a delivery environment, with only a few small challenges to address further. We have also found that an attributed, translation-based data base is the right model for the complicated collection of material that is part of a client's record. Our early prototype has

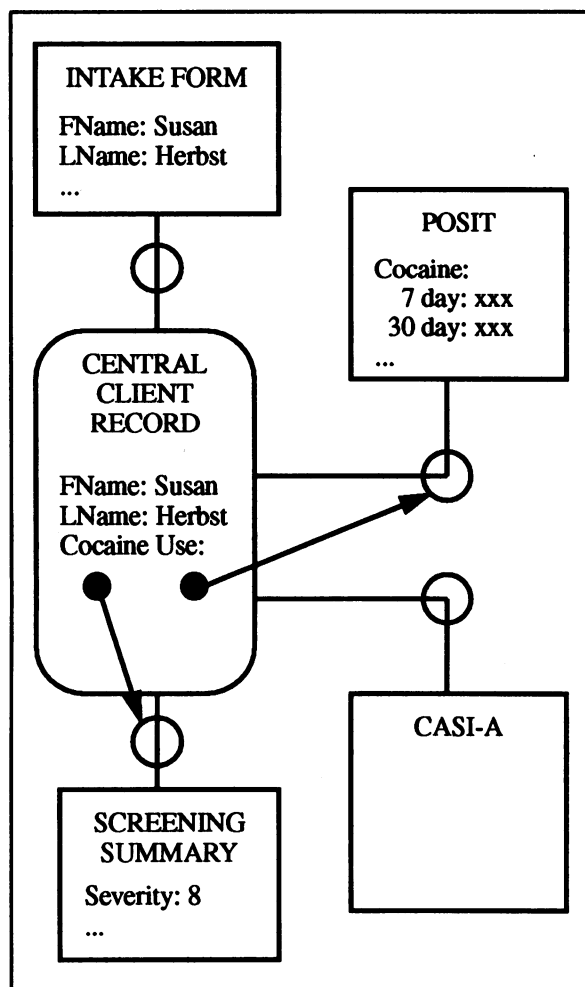


Figure 4. Abstract view of data model. In this case, the central client record stores information exported from the intake form (which is then imported into other forms). The exported POSIT data on cocaine use is lined to by the central client record, as is the screening summary severity data. The CASI-A, which is being used now, will import both the intake data and the cocaine use data.

been evaluated by fifteen substance abuse treatment professionals who has used the system to step through a counselor workday scenario. Our initial results are positive and we will continue developing the ITreS prototype to examine models for knowledge classification and dissemination.

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